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Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Re: In the Matter of Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services, ET Docket No. 98-95 (RM-9096).
Ex Parte Presentation

Dear Ms. Salas:

On Friday, May 14, 1999, Paul Najarian of the Intelligent Transportation Society of America (ITS America); Jack Bailey and Broady Cash of ARINC Inc.; James Arnold of the Federal Highway Administration; and Robert Kelly and Benigno Bartolome of Squire, Sanders & Dempsey, LLP, met with Tom Derenge and Geraldine Matise of the FCC's Office of Engineering & Technology and Herbert Zeiler of the FCC's Wireless Telecommunications Bureau concerning matters in the above-referenced proceeding. During the meeting, ITS America and ARINC submitted the attached information to FCC staff. This letter along with the attachments are being filed on behalf of all participants.

At the meeting, the parties discussed the information presented in the attached document, the status of the rulemaking proceeding, issues concerning international spectrum compatibility, and industry efforts to develop Dedicated Short Range Communications (DSRC) standards. The parties discussed the issue of North American DSRC compatibility, including DSRC-based ITS services for which interoperability is desired. Additionally, ITS America informed FCC staff about the status of industry efforts to develop a consensus on standards. ITS America also

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informed FCC staff about International Trade Union (ITU) activities with respect to spectrum allocation for DSRC-based ITS services. ARINC discussed the contents of two documents submitted to FCC staff at the meeting: one document identifies the various types of DSRC-based ITS applications and the other provides information and data about the 5.9 GHz DSRC Task Group's efforts to develop a consensus on a pre-standard conceptual approach to use the 5.9 GHz band.

Pursuant to Section 1.1206 of the Commission's Rules, an original and one copy of this letter are being filed with your office for inclusion in the public record in the above-referenced proceeding. **If** you have any questions concerning this submission, please contact the undersigned.

Sincerely,

Robert B. Kelly

Counsel for the Intelligent Transportation Society of America

RBK/beb

cc: (w/o attachments)

*Tom Derenge, Office of Engineering & Technology, FCC
*Geraldine Matise, Office of Engineering & Technology, FCC
*Herbert Zeiler, Wireless Telecommunications Bureau, FCC
James Arnold, Federal Highway Administration
Jack Bailey, ARINC Inc.
Broady Cash, ARINC Inc.
Paul Najarian, ITS America

* sent by hand delivery

DEDICATED SHORT RANGE COMMUNICATIONS (DSRC) 5.9 GHz BAND USE CONSIDERATIONS

Introduction

This paper provides additional information relevant to the ET Docket No. 98-95 RM-9096 in which ITS-A requests that the FCC allocate the entire 5.850 to 5.925 GHz (5.9 GHz) band for DSRC communications.

A 5.9 GHz DSRC Task Group, sponsored by **ASTM** E17.51 (Association for Testing and Materials), has been established to develop a consensus on a pre-standard conceptual approach to use the 5.9 GHz band. The group was established in December 1998 and is currently considering several approaches for use of the band. This decision has to be made very carefully because it is most important that an interoperable solution be developed to support the nationwide deployment of safety-related services. Therefore, interoperability is the primary requirement of any approach to use this band. Narrowband and wideband paired channel approaches will be discussed as an example of why the entire band is needed for DSRC.

Narrowband Paired Channel Approach

The narrowband paired channel approach currently being considered would use one or more modulation techniques in **a** series of downlink/uplink channel pairs separated by 39 MHz with individual widths of **4** MHz supporting a data rate of **1** Mbps to **4** Mbps. The Roadside Equipment **(RSE)** would select a downlink and uplink channel for each communication zone and the on-board equipment (OBE) would select the proper operational channel pair upon arrival in the zone. Figure 1 shows an example of how the narrowband paired channel approach could use the band.

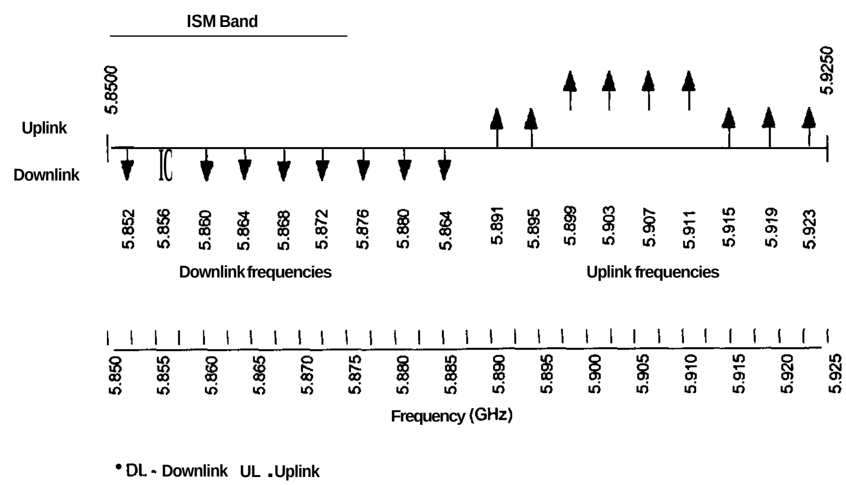

Figure 1. Example 5.9 GHz DSRC Narrowband Paired Channel Approach

Wideband Paired Channel Approach

The wideband paired channel approach would use one or more modulation techniques in a series of downlink/uplink channel pairs separated by **37** MHz with individual widths of 10 to 12 MHz supporting a data rate of 1 Mbps or more. The wideband approach would allow the use of spreadspectrum techniques with up to 3 orthogonal PN codes (currently DSS shows a lot of promise) to achieve easier channel selection, reduced channel scanning delay, smaller co-channel installation separation distances, greater interference resistance, and compensation for the delay spread at the range limits. This arrangement offers the opportunity to improve performance while holding down roadside equipment cost. This could involve using the more inexpensive non-spreadspectrum techniques in the shortest-range installations, using the spreadspectrum technique in the longer-range installations where it can do the most good, and requiring that each OBE be able to handle either one or both techniques as applicable to service their target applications. The Roadside Equipment (RSE) would select a downlink and uplink channel/PN code combination for each communication zone and require the on-board equipment (OBE) to select the proper operational channel/PN combination pair upon arrival in the zone. Figure 2 shows an example of how the wideband paired channel approach could use the band.

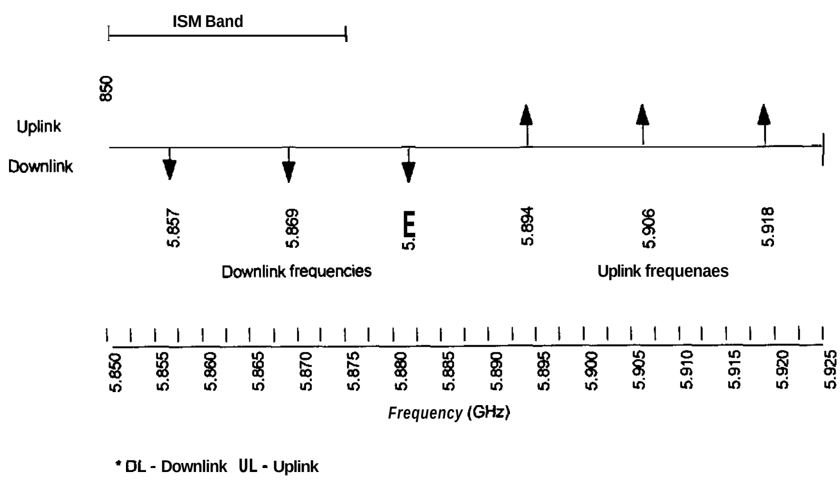

Figure 2. Example 5.9 GHz DSRC Wideband Paired Channel Approach

Comparison

Most of the debate between the two approaches occurs around whether the complexity added to the conventional approaches to meet the performance requirements for the most demanding applications will cost more than selecting the option of using spreadspectrum equipment. The selection of the approach will depend on the trade-off between performance **and** cost. The approach that is forecasted to meet all the application requirements with the least potential cost will be the one to receive the most development attention.

Data Rate

The most important part of the band use plan is the data rate. **A** data rate of 1 Mbps is being considered **as** the base data rate for DSRC in the 5.9 GHz band. This is because the estimated application requirements, as shown in Figure 2 below with more detail available in Appendix A, indicate that most of the applications can be implemented with this rate and it allows for growth of the data transfer requirements. It is also useful for reducing the errors due to fades and co-channel radar operations because more frames fit in between the anomalies. Options for 2 Mbps and **4** Mbps can be used to implement more demanding applications with shorter service ranges.

ID	TRANSACTION	Type	Range (ft)	Comm. Zone (ft)	Capture Zone (ft)	Max Speed (ft/sec)	Max Speed (mph)	One Veh Date Rate (bits/sec)	Multi Veh Date Rate (bits/sec)	Multi App Date Rate (bits/sec)
1	Toll Payment	Core	20	10	10	176.00	120	461,359	922,718	
2	Parking Payment	Core	30	20	20	51.33	35	61,783		
3	Drive-thru Payment (Gas, FastFood, Rx, etc.)	Core	20	10	10	0.00	0	21,600		
4	Probe Data Collection	Core	30	20	20	176.00	120	230,680	461,359	
5	Traffic Information	Core	30	20	20	176.00	120	76,893		
6	Access Control	Core	30	20	20	51.33	35	61,783		
7	Repair-Service Record	Core	30	20	20	0.00	0	180,000		
8	Highway/rail Intersection Warning	Core	1000	980	20	176.00	120	84,480		
9	Work Zone Safety Warning	Core	1000	980	20	176.00	120	84,480		
10	In-vehicle Signing	Core	1000	30	30	176.00	120	337,920		
11	Intersection Collision Avoidance	Upscale	1000	980	10	176.00	120	337,920		
12	Rental Car Processing and Tracking	Fleet	30	20	20	51.33	35	61,783		
13	Rollover Warning	CVO	1000	980	10	176.00	120	428,108		
14	Mainline Screening	CVO	100	80	40	176.00	120	461,359		
15	International Border Clearance	CVO	100	80	40	176.00	120	384,466		
16	Vehicle and Cargo Tracking	CVO	30	20	40	176.00	120	384,466		
17	Driver's Daily Log	CVO	30	20	20	0.00	0	86,400		
18	Vehicle Safety Inspection	CVO	30	30	30	0.00	0	72,000		
19	On-Board Safety Data	CVO	100	80	40	176.00	120	461,359		
20	Unique CVO Fleet Management	CVO	30	20	20	51.33	35	205,944		
21	Tractor to Trailer Data Transfer	CVO	10	10	10	0.00	0	720,000		
22	Emergency Vehicle Signal Preemption	Emerg.	3000	2980	20	176.00	120	97,778		
23	Transit Vehicle Signal Priority	Transit	1000	980	20	102.67	70	372,081		
24	Transit Vehicle Data Transfer (yard)	Transit	300	300	300	0.00	0	1,920,720		
25	Transit Vehicle Data Transfer (gate)	Transit	100	55	55	14.67	10	3,861,818		
26	Transit Vehicle Fueling Control	Transit	30	20	20	0.00	0	288,000		
27	Transit Access Control	Transit	60	45	30	51.33	35	39,676		
28	Railroad Database Transfer	Rail	100	80	80	0.00	0	240,720		
29	Rail Engine Fueling Control	Rail	30	20	20	0.00	0	720,000		
30	Electronic License Plate	Misc.	200	200	20	176.00	120	195,556		
31	Traffic Info/ Probe Data Collection	Multi. Instl.	1000	30	30	176	120			760,320
32	Intersection Collision Avoidance/ Transit Vehicle Signal Priority	Multi. Instl.	1000	980	25	176	120			912,384

Figure **3.** 5.9 GHz DSRC Application Data Rate Requirements

The one base data rate is important because it helps keep the common on board equipment (OBE) as simple and affordable as possible. The more sophisticated (higher data rate capable) OBE can be acquired, as necessary, by industry specific services with no additional expense to the general public. This standard approach also allows any OBE to access any RSE providing any roadside DSRC service **(as** permitted by the access codes of the service provider).

Also, for some applications like toll collection very little time is available for the extra messages needed to negotiate the data rate.

The data rate of 1 Mbps is an increase over the 600 kbps expected data rate forecast in the petition because changes in the estimates of capture zones, data for transfer, data overhead, and interference performance expectations. Some of the change is also due to additional calculations for multiple vehicle operations and the expected co-location of multiple applications on one RSE. Co-locating multiple applications on one RSE conserves installation costs and frequency requirements but it usually does not increase the available communication zone. The result is more data that must be transferred in generally the same time. Also, the development of the IEEE P1455 standard, Standard for Message Sets for Vehicle/Roadside Communications, which will apply to the new equipment being developed for 5.9 GHz DSRC operations, provides for the use of access codes. These were not generally used before. These access codes may add up to **32** bits per message. Therefore, more transfer speed will be needed to implement those applications that use long access codes. The **2** Mbps and **4** Mbps requirements are recent user additions to data needs and can be implemented with multi-level signaling techniques like QPSK, 8PSK, or QAM from a 1 Mbps base data rate.

Application Density

The next most important requirement is application density. The goal is that the band-use technique allows every application to be implemented in its normally expected location without interference from other applications. On a normal rural highway or interstate, there may be tens of miles between installations of highway-rail warning signs, construction warning signs, rollover-warning signs, mainline screening, tolls, and others. On **an** urban expressway there may be probe installations every ½ mile with toll installations every few miles in addition to the randomly placed construction warning signs and variable message signs, with rollover-warning signs at particular exits, On city streets, there may be a RSE in the intersections of the major bus and emergency routes that provide intersection collision avoidance, transit vehicle signal priority, and other traffic services. In addition, there may be an OBE in each of these specially instrumented intersections to receive the signal from the RSEs located on moving emergency vehicles. In between the intersections, in each block, there may be parking lots, service stations, fast food drive-throughs, and other electronic payment installations.

The common rule that applies to all stationary applications, except intersection applications, is that each installation has a unique communications zone. The intersection and mobile applications have the opposite rule. Their communication zones must be able to overlap all other stationary communication zones without interference.

The approach taken to solve this band use problem has been to devise plans that would meet the requirements of the most installation dense application while also being able to serve the longest range, most rarely seen, application.

After examining all the applications, it seems that the intersection applications with unknown numbers of electronic payment applications in the blocks and the occasional emergency signal preemption mobile application coming through, are the most dense foreseeable situations. The highway/rail, ice, and fog warning applications are the longest-range and the most likely isolated installations.

Separation Distance

The required separation distance for non-interfering operations between installations is the another key factor in band use planning. Assuming that BPSK modulation is used in both the downlink and uplink, the co-channel separation distance, with omnidirectional antennas, for installations in our example band use plan is calculated as generally five times the communications range of the system. If we did not use separate downlink and uplink channels, the required separation distance could be more than 50 times the range in some cases. If directional antennas (nominally 15 dBi gain) are used and pointed downward at the passing traffic, the separation distance for one antenna transmitting into the rearlobe of another antenna could be as little as equal to or less than the communication range. This is caused by the decreasing antenna gain with line-o f-sight elevation angle increase and rearlobe attenuation. These factors decrease the interference signal from nearby installations.

Narrowband Paired Channel Analysis

Now the paired channel approach can be examined more closely. Using the above considerations for the paired channel approach and nominal city blocks of 300 A we would need an omnidirectional communication range of 300 ft in each block for the intersection applications which would result in a required co-channel separation distance of 1500 ft.

Therefore, we would need to install a different channel at each intersection until we reached the sixth intersection. There the first channel could be installed again, since the interference is only possible at the maximum range of the fifth RSE and extra separation distance was obtained from the width of each intersection along the way. In this case we have used five of our nine channel pairs in the support of the intersection applications.

The sixth channel pair can be used for the emergency signal preemption application, which must be different from all stationary applications to prevent interference. Here the emergency vehicle is the controlling RSE and the OBEs are placed at each intersection. But, since we have good channel to channel isolation with this plan, no interference is expected between applications, **as** the emergency vehicle broadcasts over every communication zone in each block along the street.

This leaves three channels for short-range data transfer, electronic payment, and other applications. Fortunately these applications have very short-range communication requirements of **20** ft or less, use highly directional antennas, and are either on the side of buildings, inside garages, or in-between buildings. Since even the open space separation distance is only about 30-ft in front of the RSE and 5.6 ft on the side due to the extreme down angle of the antenna and the resulting pattern attenuation, most application installations should be out of interference range of each other. Even where service stations and parking lots are across the street from each other, the distance between installations may be between 50 to 100 ft or more. The distance of 100 A may be enough isolation but 50 may not be in some situations. Using another channel would be the best solution for the 50 ft parking lot RSE to RSE separation across a street, but careful antenna pointing may allow reuse of the same channel. Also, since each application usually has two or more RSEs, any co-owned RSEs that are not masked, 30-ft apart, or in each other's antenna sidelobes must use synchronized time slots or alternate channels.

These three additional channels would allow short-range applications, such as electronic payment, to alternate channels to prevent interference and provide an additional channel or two to use when the non-linearity of city streets and jurisdictional conflicts, cause interference.

Nine channels, as shown in figure **4** below, are just enough channels for the current applications with one channel extra for new applications, unexpected circumstances, or street irregularities.

URBAN CHANNEL DEPLOYMENT MAP

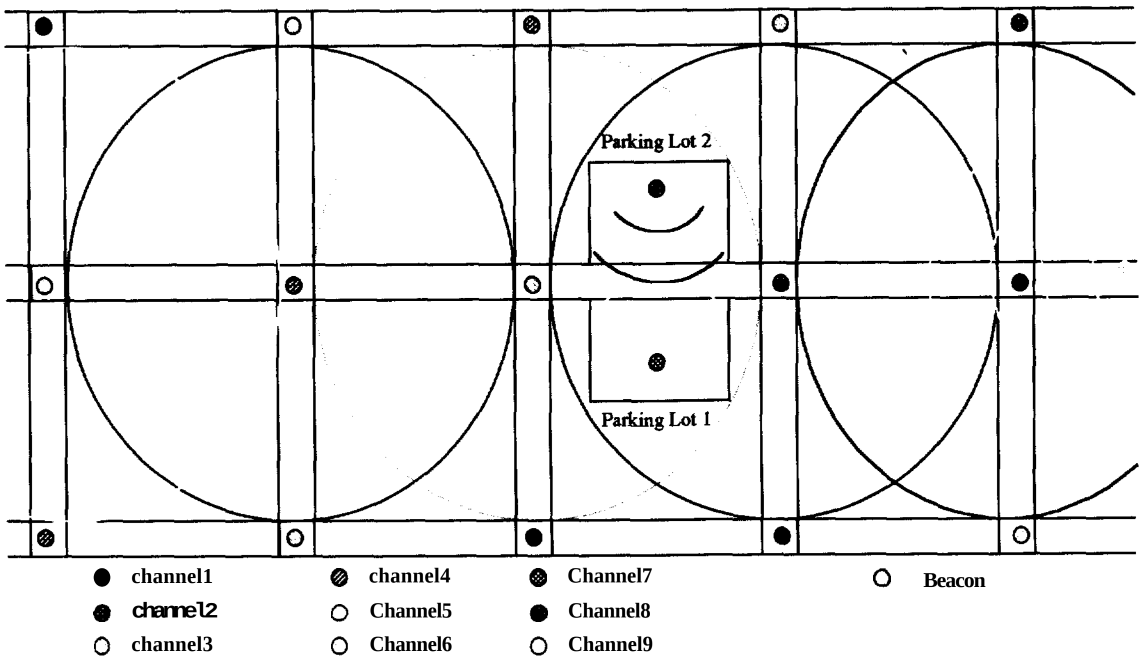

Figure **4.** 5.9GHz DSRC Example of Narrowband Urban Micro-Cell Zones

Wideband Paired Channel Analysis

Now we will examine the wideband approach. Using the separation distance considerations discussed above for the wideband approach and nominal city blocks of 300 ft we would need an omnidirectional communication range of 300 ft in each block for the intersection applications which would result in a required co-channel separation distance of 1500 ft. However, for wideband we alternate channel changes with PN code changes at each intersection until we reached the sixth intersection where the first channel/PN code pair could be used again. But now we have used five of the nine channel/PN pairs in the support of the intersection applications. The emergency signal preemption application may use a channel/PN code pair in the third channel, which must be different from all stationary applications to prevent interference. Here the emergency vehicle is the controlling RSE and the OBEs are placed at each intersection. But, since we have good channel to channel isolation with this plan no interference is expected between applications as the emergency vehicle broadcasts over every communication zone in each block along the street. This leaves the last two channel/PN pairs for short-range data transfer, electronic payment, or other applications. Fortunately these applications have very short-range communication requirements of 20 ft or less, use highly directional antennas, and are either on the side of buildings, inside garages, or in-between buildings. Since even the open space separation distance is only about **30-ft** in front of the RSE and ***5.6*** ft on the side due to the extreme down angle of the antenna and the resulting pattern attenuation, most application installations should be out of interference range of each other. Even where service stations and parking lots are across the street from each other, the distance between installations may be between 50 to 100 ft or more, which is still more than needed. Also, since each application usually has two or more RSEs, any RSEs that are not masked, 30-ft apart, or in each other's antenna sidelobes can be synchronized to transmit and receive at unique times. Therefore, all short-range applications share the last three channel/PN code combinations where one combination is available to resolve unexpected multipath interference.

URBAN CHANNEL and PN code DEPLOYMENT MAP

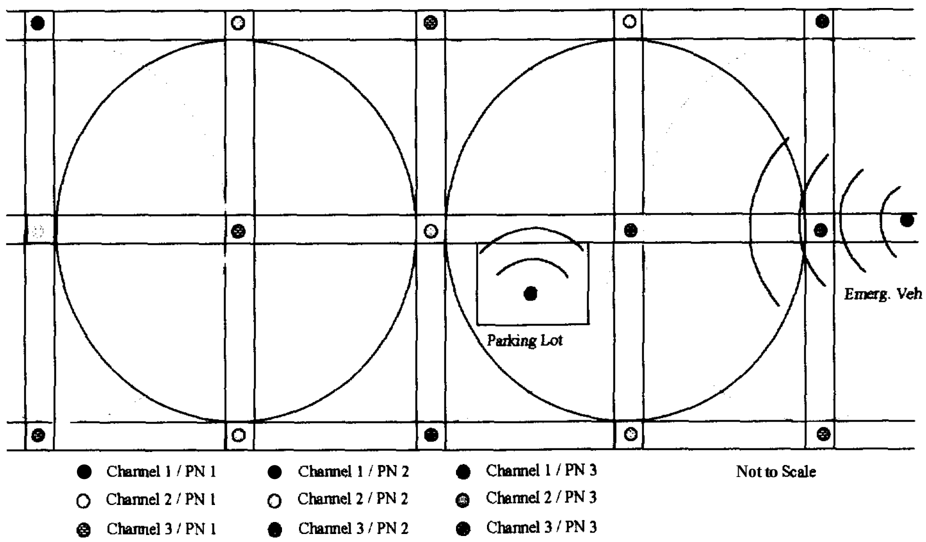

Figure 5. 5.9GHz DSRC Example of Wideband Urban Micro-Cell Zones

The wideband approach uses three channels and nine available channel/PN code combinations in the 75 MHz, **as** shown in figure 5 above. Two channels and five combinations are used for intersection applications, one channel/PN code combination for emergency vehicle signal preemption and three combinations for short-range data transfer, electronic payment, or other applications.

Conclusion

With **a** possible spectrum efficiency of 1bit/Hz in the most demanding case and ¼ bit/Hz in the general case, and the density **of** the applications pressuring the limits **of** the spectrum usage, 75 MHz is the right amount of spectrum for the DSRC applications.

Appendix A: Transaction Database

1.0 Introduction

This appendix contains the calculations for the data rates associated with the estimated transaction data that is expected to be transferred during DSRC sessions. A transaction is a complete communications session that implements a data transfer between the roadside **and** a vehicle. Each transaction consists **of** a set **of** messages.

TRANSACTION
PARAMETERS

D	TRANSACTION	Type	Range (ft)	Comm. Zone (ft)	Transaction Zone (ft)	Maximum Speed (ft/sec)	Maximum Speed (mph)	No. of Vehicles	Data Transfers
1	Toll Payment	Core	20	10	10	176.00	120	[illegible]	3
2	Parking Payment	Core	30	20	20	51.33	35	1	3
3	Drive-thru Payment (Gas, FastFood, Rx, etc.)	Core	20	10	10	0.00	0	1	5
4	**Probe Data Collection**	**Core**	**30**	**20**	**20**	**176.00**	**120**	**1**	**3**
5	**Traffic Information**	**Core**	**30**	**20**	**20**				
[illegible]	[illegible]	Core	30	20	20				
[illegible]	[illegible]	**Core**	**30**	**20**	**20**	**0.00**			
[illegible]	[illegible]	Core	1000	980	20	176.00	120	1	1
[illegible]	[illegible]	Core	1000	980	20	176.00	120	1	1
[illegible]	[illegible]	**Core**	**1000**	**30**	**30**	**176.00**	**120**	**1**	**1**
[illegible]	[illegible]	**Upscale**	**1000**	**980**	**10**	**176.00**	**120**	**1**	**1**
[illegible]	[illegible]	**Fleet**	**30**	**20**	**20**	**51.33**	**35**	**1**	**5**
[illegible]	[illegible]	CVO	1000	980	10	176.00	120	1	1
[illegible]	[illegible]	CVO	100	80	40	176.00	120	1	5
[illegible]	[illegible]	**CVO**	**100**	**80**	**40**	**176.00**	**120**	**1**	**5**
[illegible]	[illegible]	**CVO**	**30**	**20**	**40**	**176.00**	**120**	**1**	**5**
17	Driver's Daily Log	CVO	30	20	20	0.00	0	[illegible]	Unk
18	Vehicle Safety Inspection	CVO	30	30	30	0.00	0	1	Unk
19	On-Board Safety Data	CVO	100	80	40	176.00	120	[illegible]	5
20	**Unique** CVO Fleet Management	CVO	30	20	20	51.33	35	1	5
21	**Tractor** to Trailer Data Transfer	CVO	10	10	10	0.00	0	1	Unk
22	Emergency Vehicle Signal Preemption	Emerg.	3000	2980	20	176.00	120	1	1
23	Transit Vehicle Signal Priority	Transit	1000	980	20	102.67	70	[illegible]	5
24	Transit Vehicle Data Transfer (yard)	Transit	300	300	300	0.00	0	1	Unk
25	Transit Vehicle Data Transfer (gate)	Transit	100	55	55	14.67	10	1	Unk
26	Transit Vehicle Fueling Control	Transit	30	20	20	0.00	0	1	Unk
27	**Transit Access Control**	Transit	60	45	30	51.33	35	[illegible]	5
28	**Railroad Database Transfer**	Rail	100	80	80	0.00	0	1	Unk
29	**Rail Engine Fueling Control**	Rail	30	20	20	0.00	0	1	Unk
30	**Electronic License Plate**	Misc.	200	200	20	176.00	120	[illegible]	2

TRANSACTION
PARAMETERS
(One 111 Vehicle)

ID	Slot Overhead	Frame Overhead	Processing Time (seconds)	Maximum Retries	Maximum Read Time (seconds)	Stopped Read Time (seconds)	Read Time /Frame (seconds)	Frames Used	Overhead Slots	Data Slots /Frame
1	0.64	0.213	0.01	3	0.046818182		0.00520202	3	2	1
2	0.64	0.213	0.04	3	0.34961039		0.038845599	3	2	1
3	0.64	0.213	0.02	3	see --->	1	0.111111111	3	2	1
4	0.64	0.213	0.02	3	0.093636364		0.01040404	3	2	1
5	0.64	0.640	0.02	3	0.093636364		0.031212121	1	2	1
6	0.64	0.213	0.04	3	0.34961039		0.038845599	3	2	1
7	0.64	0.213	0.04	3	see --->	1	0.013333	25	2	1
8	0.64	0.320	0	3	0.113636364		0.037879	1	2	2
9	0.64	0.320	0	3	0.113636364		0.037879	1	2	2
10	0.64	0.427	0	3	0.170454545		0.014205	4	2	4
11	0.64	0.160	0	3	0.056818182		0.0[illegible]8939	1	2	2
12	0.64	0.213	0.04	3	0.34961039		0.038846	3	2	1
13	0.64	0.213	0.04	3	0.016818182		0.005606	1	2	1
14	0.64	0.427	0.04	3	0.187272727		0.010404	6	2	4
15	0.64	0.427	0.04	3	0.187272727		0.012485	5	2	4
16	0.64	0.427	0.04	3	0.187272727		0.012485	5	2	4
17	0.64	0.427	0.04	3	see --->	1	0.055556	6	2	4
18	0.64	0.427	0.04	3	see --->	1	0.066667	5	2	4
19	0.64	0.427	0.04	3	0.187272727		0.010404	6	2	4
20	0.64	0.427	0.04	3	0.349610391		0.023307	5	2	4
21	0.64	0.427	0.04	3	see --->	0.1	0.006667	5	2	4
22	0.64	0.213	0.04	3	0.073636364		0.024545	1	2	1
23	0.64	0.427	0.04	3	0.154805195		0.012900	4	2	4
24	0.64	0.427	0.02	3	see —z	60	0.002499	8003	2	4
25	0.64	0.427	0.01	3	3.74		0.001243	1003	2	4
26	0.64	0.427	0.04	3	see --->	0.1	0.016667	2	2	4
27	0.64	0.213	0.04	3	0.544415584		0.06049062	3	2	1
28	0.64	0.427	0.04	3	see --->	60	0.019940	1003	2	4
29	0.64	0.427	0.04	3	see --->	0.1	0.006667	5	2	4
30	0.64	0.213	0.04	3	0.073636364		0.012272727	2	2	1

TRANSACTION
PARAMETERS

'ID	Slot Size (bits)	Max Slot Data (bits)	Bit Times Used (bits)	One Veh Data Rate (bits/sec)	Total Packet Data (bits)	BST	BST Size (bits)	Data Broadcast w/BST	" Size (bits)	VST
1	800	512	7200	461359	1280	BST	232	None	0	None
2	800	512	7200	61783	1280	BST	232	None	0	None
3	800	512	7200	21600	1280	BST	232	None	0	None
4	800	512	7200	230680	1280	BST	232	None	0	None
5	800	1536	2400	76893	1792	BST	232	3 pages	1536	None
6	800	512	7200	61783	1280	BST	232	None	0	None
7	800	512	60000	180000	12544	BST	232	None	0	None
8	800	1024	3200	84480	744	BST	232	One page	512	None
9	800	1024	3200	84480	744	BST	232	One page	512	None
10	800	2048	19200	337920	6400	BST	232	None	0	None
11	800	512	3200	168960	744	BST	232	One page	512	None
12	800	512	7200	61783	1280	BST	232	None	0	None
13	800	512	2400	428108	744	BST	232	One page	512	None
14	800	2048	28800	461359	5992	BST	232	None	0	VST
15	800	2048	24000	384466	3432	BST	232	None	0	VST
16	800	2048	24000	384466	4712	BST	232	None	0	VST
17	800	2048	28800	86400	6760	BST	232	None	0	VST
18	800	2048	24000	72000	4712	BST	232	None	0	VST
19	800	2048	28800	461359	6760	BST	232	None	0	VST
20	800	2048	24000	205944	4712	BST	232	None	0	VST
21	800	2048	24000	720000	4712	BST	232	None	0	VST
22	800	512	2400	97778	744	BST	232	One page	512	None
23	800	2048	19200	372081	2664	BST	232	None	0	VST
24	800	2048	38414400	1920720	16384616	BST	232	None	0	VST
25	800	2048	4814400	3861818	2048616	BST	232	None	0	VST
26	800	2048	9600	288000	768	BST	232	None	0	None
27	800	512	7200	39676	1280	BST	232	None		None
28	800	2048	4814400	240720	2048616	BST	232	None	0	VST
29	800	2048	24000	720000	4712	BST	232	None	0	VST
30	800	512	4800	195556	768	BST	232	None		None

TRANSACTION
PARAMETERS
(One 111 Vehicle)

D	VST Size (bits)	Data Request Command	" Size (bits)	Requested Page (up)	" Size (bits)	Write and Sleep Commands	" Size (bits)	Requested Page (down)	" Size (bits)
1	0	Added to BST Frame	0	One page	512	Write and Sleep	128	One page	512
2	0	Added to BST Frame	0	One page	512	Write and Sleep	128	One page	512
3	0	Added to BST Frame	0	One page	512	Write and Sleep	128	One page	512
4	0	Added to BST Frame	0	One page	512	Write and Sleep	128	One page	512
5	0	None	0	None	0	None	0	None	0
6	0	Added to BST Frame	0	One page	512	Write and Sleep	128	One page	512
7	0	Added to BST Frame	0	Twelve pages	6144	Write and Sleep	128	Twelve pages	6144
8	0	None	0	None	0	None	0	None	0
9	0	None	0	None	0	None	0	None	0
10	0	None	0	None	0	Write only added to BST	0	Twelve pages	6144
11	0	None	0	None	0	None	0	None	0
12	0	Added to BST Frame	0	One page	512	Write and Sleep	128	One page	512
13	0	None	0	None	0	None	0	None	0
14	296	1 page	*64*	6 pages	2688	Write and Sleep	128	6 pages	2688
15	296	1 page	*64*	3 pages	1408	Write and Sleep	128	3 pages	1408
16	296	1 page	*64*	4 pages	2048	Write and Sleep	128	4 pages	2048
17	296	1 page	*64*	12 pages	6144	Sleep	*64*	None	0
18	296	1 page	*64*	4 pages	2048	Write and Sleep	128	4 pages	2048
19	296	1 page	*64*	12 pages	6144	Sleep	*64*	None	0
20	296	1 page	*64*	4 pages	2048	Write and Sleep	128	4 pages	2048
21	296	1 page	*64*	4 pages	2048	Write	128	4 pages	2048
22		Added to BST Frame	0	None	0	None	0	None	0
23	296	1 page	*64*	2 pages	1024	Write	128	2 pages	1024
24	296	1 page	*64*	16000 pages	16384000	Sleep	*64*	None	0
25	296	1 page	*64*	2000 pages	2048000	Sleep	*64*	None	0
26		Added to BST Frame	0	1 page	512	None	0	None	0
27		Added to BST Frame	0	1 page	512	Write and Sleep	128	One page	512
28	296	1 page	*64*	6 pages	2048000	Sleep	*64*	None	0
29	296	1 page	*64*	4 pages	2048	Write	128	4 pages	2048
30		Added to BST Frame	0	1 page	512	Sleep	*64*		

TRANSACTION PARAMETERS (One [1] Vehicle)

ID	ACK	LACK Size (bits)						
1		24						
2		24						
3		24						
4		24						
5		24						
6		24						
7		24						
8								
9								
10		24						
11								
12		24						
13								
14		24						
15		24						
16		24						
17		24						
18		24						
19		24						
20		24						
21		24						
22								
23		24						
24		24						
25		24						
26		24						
27		24						
28		24						
29		24						
30		24						

(MULTIPLE VEHICLES)

ID	TRANSACTION	Type	Range	Comm. Zone	Capture Zone	Speed	Speed	Data Transfer	Slot Overhead	Overhead
			(ft)	(ft)	(ft)	(ft/sec)	(mph)			
1	Toll Payment	Core	20	10	10	176.00	120	3	0.64	0.427
4	Probe Data Collection	Core	30	20	20	176.00	120	3	0.64	0.427
31	Traffic Info/ Probe Data Collection	Multi. Instl.	1000	30	30	176.00	120	1	0.64	0.427
32	Intersection Collision Avoidance/ Transit Vehicle Signal Priority	Multi. Instl.	1000	980	17	176.00	120	1	0.64	0.160

TRANSACTION
PARAMETERS
(MULTIPLE VEHICLES)

ID	Processing Time (seconds)	Maximum Retries	Maximum Read Time (seconds)	Stopped Read Time (seconds)	Read Time /Frame (seconds)	Frames Used	Overhead Slots	Data Slots /Frame	Slot Size (bits)	Max Slot Data (bits)	Bit Times Used (bits)	No. of Vehicles
1	0.01	3	0.046818182		0.00520202	3	2	4	800	2048	14400	4
4	0.02	3	0.093636364		0.01040404	3	2	4	800	2048	14400	4
31	0	3	0.170454545		0.006313	9	2	4	800	2048	43200	[illegible]
32	0	3	0.096590909		0.003220	10	2	2	800	512	32000	1

TRANSACTION

PARAMETERS

(MULTIPLE VEHICLES)

ID	Multi Veh Date Rate (bits/sec)	No. of Applications	Multi App Date Rate (bits/sec)	Total Packet Data/Vehicle (bits)	BST	" *Size* (bits)	Broadcast Data	" Size (bits)	VST	" Size (bits)
1	922718	1		1280	BST	232	None		None	
4	461359	1		1280	BST	232	None		None	
31		2	760320	7808	BST	232	None		None	
32		2	993882	3536	BST	232	1 page	512	None	

TRANSACTION
PARAMETERS

ID	Data Request Command	" Size (bits)	Requested Page (up)	" Size (bits)	Write and Sleep Commands	" Size (bits)	Requested Page (down)	" Size (bits)	ACK	" Size (bits)	BST
1	Added to BST Frame	0	1 page	512	Write and Sleep	128	1 page	512		24	
4	Added to BST Frame	0	1 page	512	Write and Sleep	128	1 page	512		24	
31	Added to BST Frame	0	None	0	Write only added to BST	0	12 pages	6144		24	BST
32	Added to BST Frame	0	None	0							BST

TRANSACTION
PARAMETERS
(MULTIPLE VEHICLES)

ID	" Size (bits)	Broadcast Data	" Size (bits)	VST	" Size (bits)	Data Request Command	" Size (bits)	equeste Page (up)	" Size (bits)	Write and Slee Commands	" Size (bits)	equeste Page (down)
1												
4												
31	232	None		None		Added to BST Frame	0	1 page	512	Write and Sleep	128	1 page
32	232			VST	296	1 page	64	2 pages	1024	Write	128	2 pages

TRANSACTION PARAMETERS (MULTIPLE VEHICLES)

ID	" Size (bits)	ACK	" Size (bits)
1			
4			
31	512		24
32	1024		24

5.9 GHz DSRC
Data **Rates**

D	TRANSACTION	Type	Range	Comm. Zone	Capture Zone	Max Speed	Max Speed	One Veh Date Rate	Multi Veh Date Rate	Multi App Date Rate
			(ft)	(ft)	(ft)	(ft/sec)	(mph)	(bits/sec)	(bits/sec)	(bits/sec)
1	Toll Payment	Core	20	10	10	176.00	120	461,359	922,718	
2	Parking Payment	Core	30	20	20	51.33	35	61,783		
3	Drive-thru Payment (Gas, FastFood, Rx, etc.)	Core	20	10	10	0.00	0	21,600		
4	Probe Data Collection	Core	30	20	20	176.00	120	230,680	461,359	
5	Traffic Information	Core	30	20	20	176.00	120	76,893		
6	Access Control	Core	30	20	20	51.33	35	61,783		
7	Repair-Service Record	Core	30	20	20	0.00	0	180,000		
8	Highway/rail Intersection Warning	Core	1000	980	20	176.00	120	84,480		
9	Work Zone Safety Warning	Core	1000	980	20	176.00	120	84,480		
0	In-vehicle Signing	Core	1000	30	30	176.00	120	337,920		
1	Intersection Collision Avoidance	Upscale	1000	980	10	176.00	120	168,960		
2	Rental Car Processing and Tracking	Fleet	30	20	20	51.33	35	61,783		
3	Rollover Warning	CVO	1000	980	10	176.00	120	428,108		
4	Mainline Screening	CVO	100	80	40	176.00	120	461,359		
5	International Border Clearance	CVO	100	80	40	176.00	120	384,466		
6	Vehicle and Cargo Tracking	CVO	30	20	40	176.00	120	384,466		
7	Driver's Daily Log	CVO	30	20	20	0.00	0	86,400		
8	Vehicle Safely Inspection	CVO	30	30	30	0.00	0	72,000		
9	On-Board Safely Data	CVO	100	80	40	176.00	120	461,359		
:0	Unique CVO Fleet Management	CVO	30	20	20	51.33	35	205,944		
:1	Tractor to Trailer Data Transfer	CVO	10	10	10	0.00	0	720,000		
:2	Emergency Vehicle Signal Preemption	Emerg.	3000	2980	20	176.00	120	97,778		
'3	Transit Vehicle Signal Priority	Transit	1000	980	20	102.67	70	372,081		
:4	Transit Vehicle Data Transfer (yard)	Transit	300	300	300	0.00	0	1,920,720		
:5	Transit Vehicle Data Transfer (gate)	Transit	100	55	55	14.67	10	3,861,818		
:6	Transit Vehicle Fueling Control	Transit	30	20	20	0.00	0	288,000		
:7	Transit Access Control	Transit	60	45	30	51.33	35	39,676		
:8	Railroad Database Transfer	Rail	100	80	80	0.00	0	240,720		
:9	Rail Engine Fueling Control	Rail	30	20	20	0.00	0	720,000		
i0	Electronic License Plate	Misc.	200	200	20	176.00	120	195,556		
i1	Traffic Info/ Probe Data Collection	Multi. Instl.	1000,	30	30	176,	120			760,320

ARINC

5.9 GHz
DSRC Band Utilization
Conceptual Proposals

Prepared for
ITS-A/FCC
Meeting
May 14,1999

CATEGORIZED APPLICATIONS

SHORT RANGE CORE APPLICATIONS (FOR ALL VEHICLES)

- (LANE BASED) TOLL COLLECTION
- (OPEN ROAD) TOLL COLLECTION
- PARKING PAYMENT
- GAS (FUEL) PAYMENT
- ELECTRONIC LICENSE PLATE
- FAST FOOD PAYMENT
- DRV-THRU PHARMACY PAYMENT
- PROBE DATA COLLECTION
- ACCESSCONTROL
- REPAIR-SERVICE RECORD
- RENTAL CAR PROCESSING **and** TRACKING
- TRAFFIC INFORMATION

LONG RANGE CORE APPLICATIONS (FOR ALL VEHICLES)

- HIGHWAY/RAIL INTERSECTION WARNING
- INTERSECTION COLLISION AVOIDANCE
- WORK ZONE SAFETY WARNING
- IN-VEHICLE SIGNING

APPLICATIONS FOR HEAVY TRUCKS, BUSES, TRAINS, EV (LONG RANGE)

- ROLLOVER WARNING
- MAINLINE SCREENING
- INTERNATIONAL BORDER CLEARANCE
- VEHICLE AND CARGO TRACKING
- DRIVER'S DAILY LOG
- VEHICLE SAFETY INSPECTION
- ON-BOARD SAFETY DATA
- UNIQUE CVO FLEET MANAGEMENT
- TRACTOR TO TRAILER DATA TRANSFER
- EMERGENCY VEHICLE SIGNAL PREEMPTION
- TRANSIT VEHICLE SIGNAL PRIORITY
- (TRANSIT) ACCESS CONTROL
- TRANSIT VEHICLE DATA TRANSFER **(yard)**
- TRANSIT VEHICLE DATA TRANSFER **(gate)**
- TRANSIT VEHICLE REFUELING
- RAILROAD DATABASE TRANSFER
- RAIL ENGINE FUELING CONTROL

CVO - Commercial Vehicle Operations
DRV - Drive
EV -Emergency Vehicle

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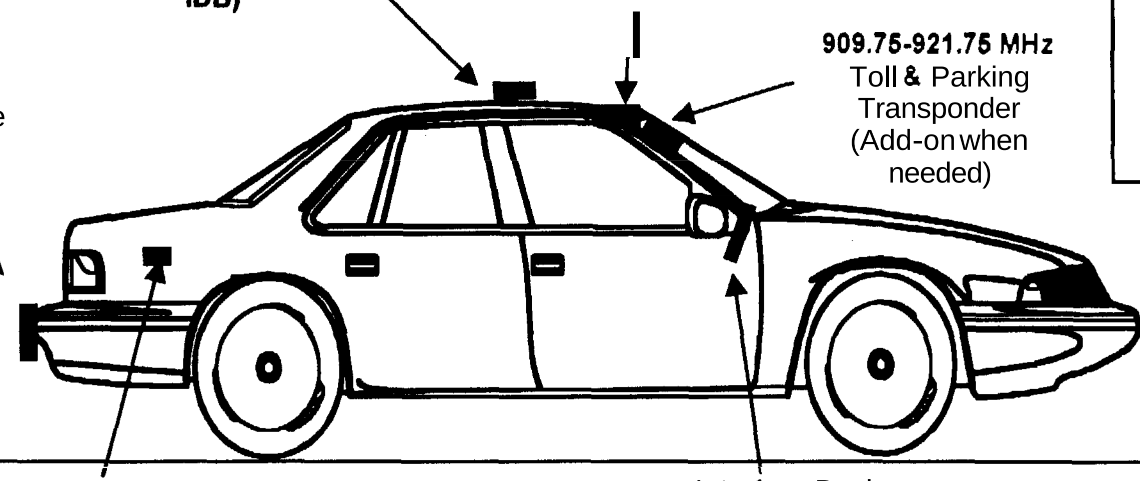
Common Vehicle On-Board Equipment



Other ITS Communications Equipment

87.5-107.9 MHz
FM subcarrier

800 to **900 MHz**
Cellular Phone

1575.42MHz
GPS Receiver

1800 to 1900 **MHz**
PCS Phone

Multiple Bands
Two-way Radio

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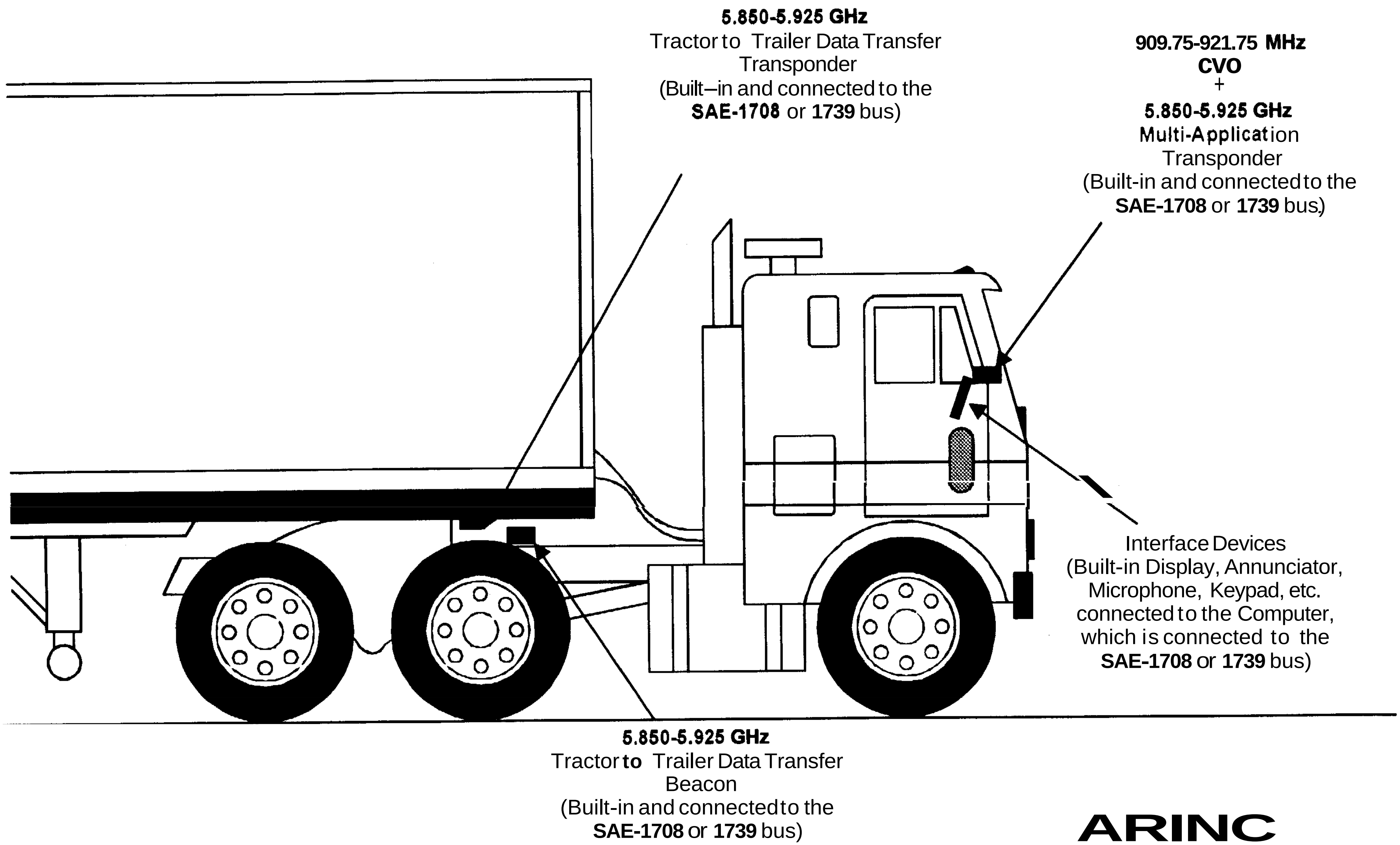
CVO
On-Board Equipment



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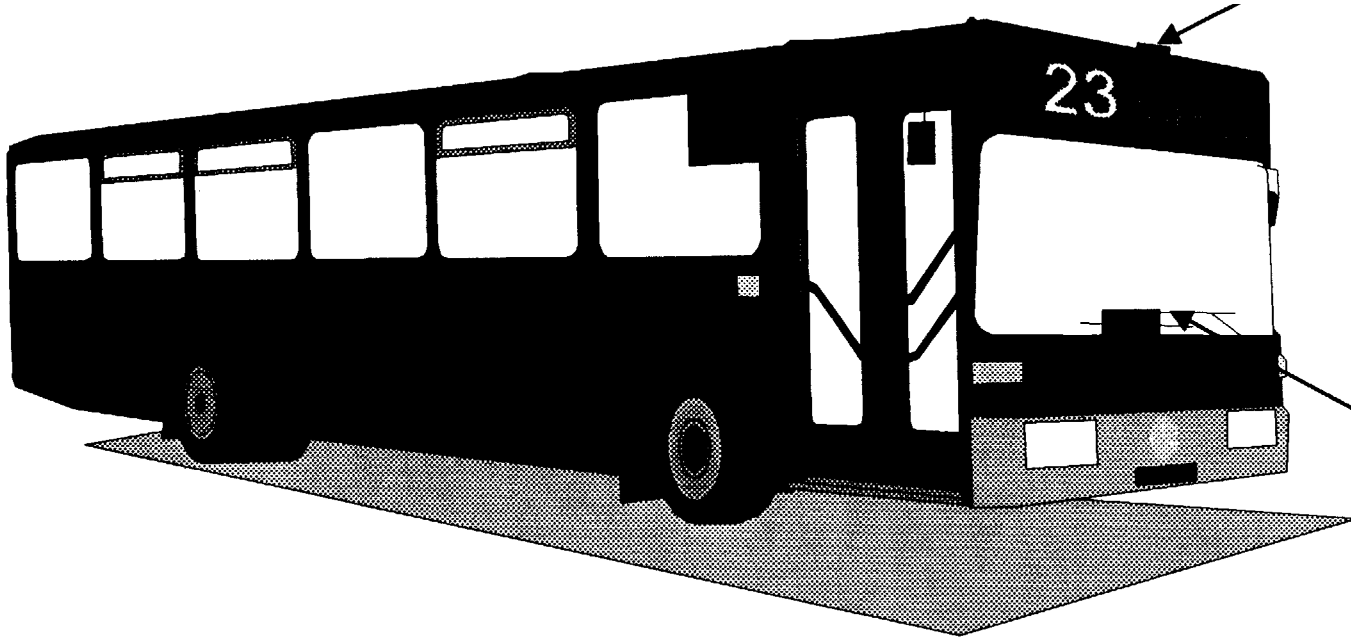
TRANSIT
On-Board Equipment

5.850-5.925 GHz
Multi-Application
Transponder
(Built-in and connected to the
SAE-1708 or 1739 bus)



Interface Devices
(Built-in Display, Annunciator,
Microphone, Keypad, etc.
connected to the Computer,
which is connected to the
SAE-1708 or 1739 bus)

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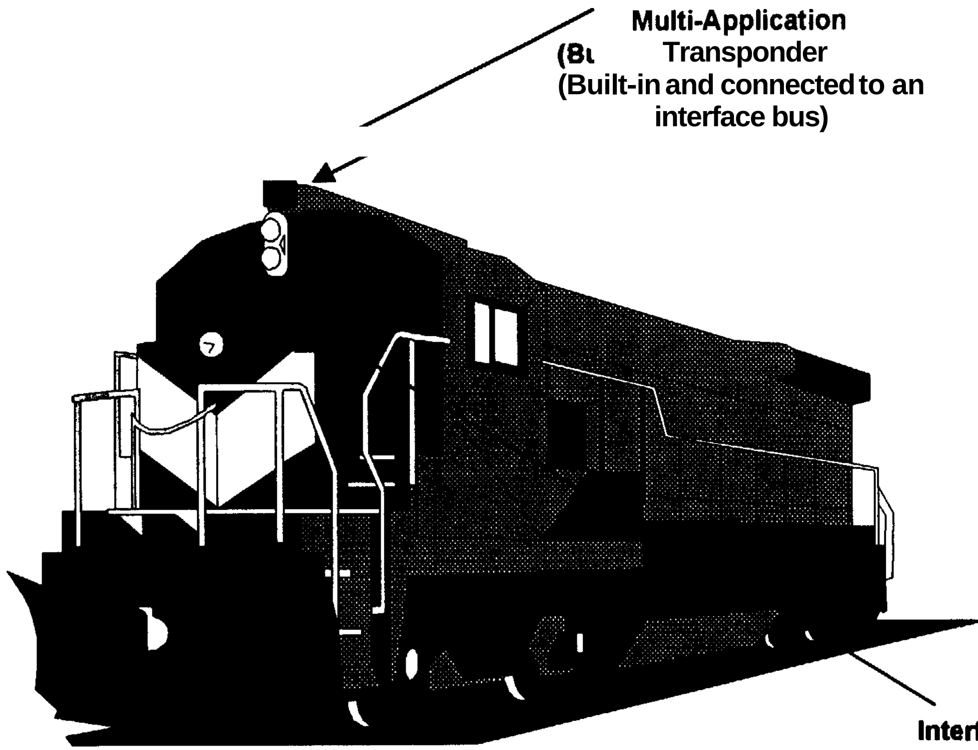
RAIL ENGINE
On-Board Equipment



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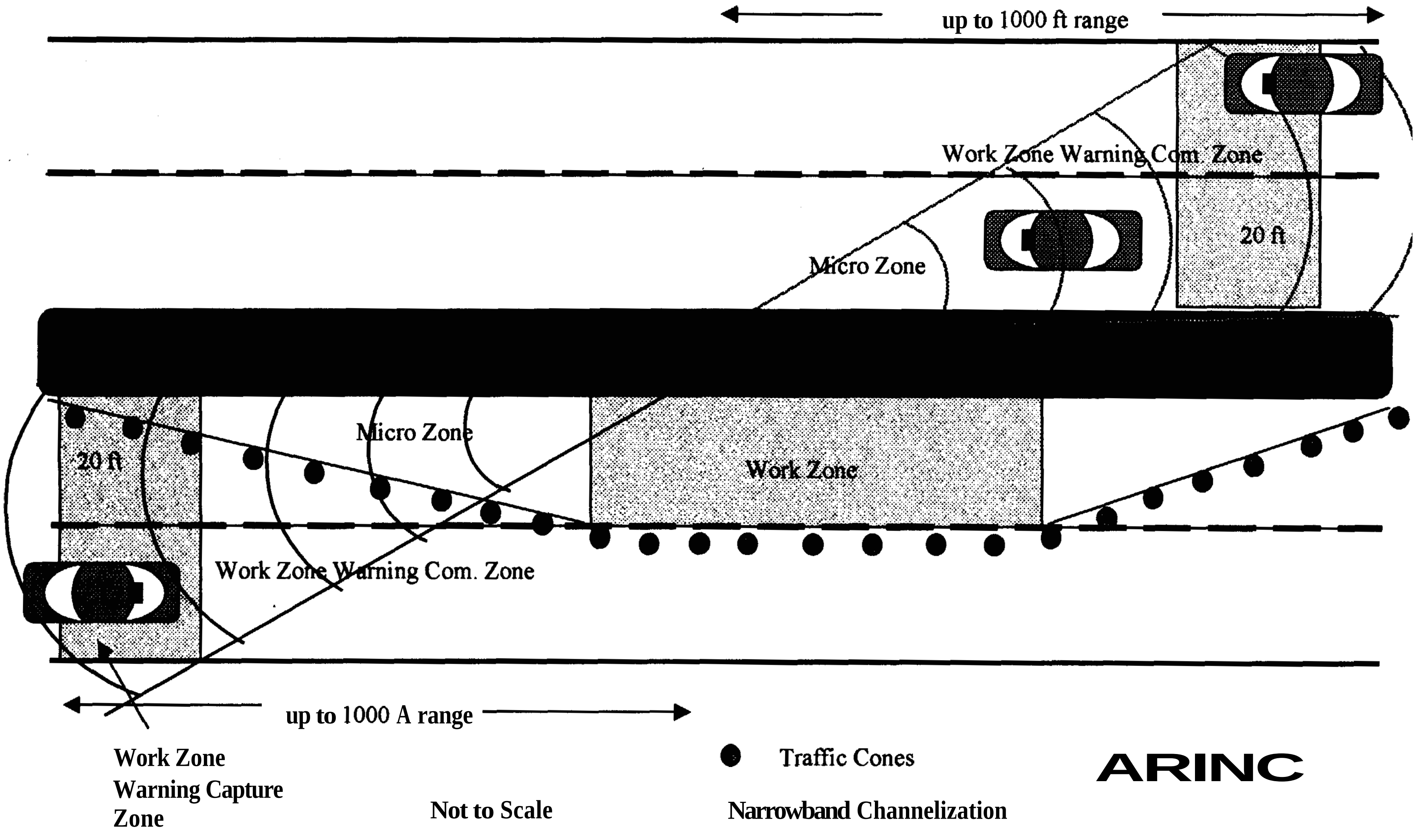
EXAMPLE MICRO/PICO-CELL COMMUNICATION ZONES

WORK ZONE WARNING



Not to Scale

Narrowband Channelization

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FCC_EXPLS.PPT/5-12-99/bcash